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FLUORESCENT LAMP
FLUORESZENZLAMPE
LAMPE FLUORESCENTE
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ABSTRACT EP 1146544 A1
A **fluorescent lamp** of the present invention has a **fluorescent** substance film formed on an inner surface and a discharge medium containing xenon-gas filled in the glass tube having sealing portions at both ends. In one end of the glass tube, an inner **electrode** is arranged. A first feeding lead wire is connected to the inner **electrode** penetrating one of the sealing portion with airtight. On the outer surface of the glass tube, an outer **electrode** composed of a conductor spirally **wound** around it along the axial direction of the tube. At the other end of the glass tube, a second feeding lead wire is buried in the sealing portion at one end and the other end is lead out of the glass tube. An end of the outer **electrode** is electrically connected and mechanically fixed to the second feeding lead wire. Further, an outer surface of the outer **electrode** including the glass tube is covered with a translucent resin film layer and thereby, the outer **electrode** is fixed to the outer surface of the glass tube integrally.
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INVENTOR:
YANO, Hidetoshi ...

...ABSTRACT A1
A **fluorescent lamp** of the present invention has a **fluorescent** substance film formed on an inner surface and a discharge medium

containing xenon-gas filled...

...having sealing portions at both ends. In one end of the glass tube, an inner **electrode** is arranged. A first feeding lead wire is connected to the inner **electrode** penetrating one of the sealing portion with airtight. On the outer surface of the glass tube, an outer **electrode** composed of a conductor spirally **wound** around it along the axial direction of the tube. At the other end of the...

...the other end is lead out of the glass tube. An end of the outer **electrode** is electrically connected and mechanically fixed to the second feeding lead wire. Further, an outer surface of the outer **electrode** including the glass tube is covered with a translucent resin film layer and thereby, the outer **electrode** is fixed to the outer surface of the glass tube integrally.

...SPECIFICATION A1

FIELD OF THE INVENTION

The present invention relates to a **fluorescent lamp** and more particularly to a **fluorescent lamp** that is suited for a light source for the back-lighting of liquid crystal displays...

...used in personal computers, car-navigation displays and various electronic devices.

BACKGROUND OF THE INVENTION

Fluorescent lamps are used as light sources for the back-lighting of liquid crystal displays to irradiate...

...displays, stable and sufficient light intensity, uniform distribution of luminance in the axial direction of **lamp** tube in the wide temperature range from -40(degree)C to 85(degree) or under the control of light intensity from several % to 100%, are demanded for **fluorescent lamps** themselves as light sources for the back-lighting jointly for small-sized luminance tube diameter and extended tube length.

However, because the light intensity of these **fluorescent lamps** is insufficient at low ambient temperature and mercury may cause the environmental pollution, the development of **fluorescent lamps** without using mercury gas is demanded.

On the other hand, a small discharge **lamp** or a **fluorescent lamp** using inert gas such as neon gas, krypton gas or xenon gas was disclosed in Japanese Laid-Open Patent Publication (Kokai) No. 57-63756. In this discharge **lamp** , one of two **electrodes** is provided in a glass tube and the other **electrode** is provided outside the glass tube. The former **electrodes** is provided over the almost an entire length of the glass tube along its longitudinal direction and the latter **electrode** is provided on the outer surface of the glass tube facing the former **electrode** . It is disclosed that the discharge **lamp** is a small one having a diameterof 2 to 10 mm and of a length...

...displaying characters, numerals or symbols by a single or a plurality of straight or bent **lamps** combined. It ia also disclosed that the discharge **lamp** is used as energy-saving type pilot **lamps** or beacon lights.

However, in the case of conventional discharge **lamps** or **fluorescent lamps** in such a structure, it is difficult to form an uniform discharge distance to an outer **electrode** from an inner **electrode** for the overall length of an inner **electrode** and as a result, such problems are caused that a partial discharge is produced and...

...other words, for back-lighting sources of liquid crystal displays, for example, such a slender **fluorescent lamp** using a glass tube having an outer diameter of 1.6 to 10 mm in...

...mm is used, and it is extremely difficult in view of manufacturing technology to provide **electrodes** so as to make a discharge distance uniform for the overall length in a glass tube.

Further, in liquid crystal displays, **fluorescent lamps** are often subject to the effect of vibration depending on the using condition and

an inner **electrode** is deformed locally. Therefore, it is difficult to maintain a discharge distance always constant.

Furthermore...

...it is most difficult to make a discharge distance of the inner to the outer **electrode** becomes uniform over the overall length.

Next, in conventional gas discharge **lamps** or **fluorescent lamps** in the structure described above, even if a glow discharge area was formed for the overall length of a **lamp** and in particular, when a discharge medium containing xenon is used, electrons are actively discharged around the inner **electrode** and therefore, a diffused positive column is hardly formed and as a result, the generation of ultraviolet rays is suppressed. Accordingly, when this **electrode** structure is used for **fluorescent lamps** having the glass tube, inner wall of which is coated with **fluorescent** substance for the purpose of emitting a luminance by ultraviolet rays excited, there is such...

...object of the present invention is to solve the above-mentioned problems involved in conventional **fluorescent lamps** . In other words, it is an object of the present invention to provide a **fluorescent lamp** for the back-lighting of liquid crystal displays which provide a stable luminescence with a...

...using rare gas containing xenon-gas as a discharge medium.

SUMMARY OF THE INVENTION

A **fluorescent lamp** according to the present invention comprises a glass tube both ends of which are sealed airtight filled with discharge medium therein, a **fluorescent** substance layer formed on the inner wall of the glass tube; an inner **electrode** arranged at one end in the glass tube and given with one of potentials, and an outer **electrode** composed of a conductor spirally **wound** around the glass tube between both ends at a prescribed pitch along the axis of the tube.

Further, in the **fluorescent lamp** according to the present invention, the discharge medium is composed of xenon-gas or a mixture of xenon gas and other rare gas.

Further, in the **fluorescent lamp** according to the present invention, the outer surface of the outer **electrode** is covered with a translucent resin film layer togather with the glass tube and thereby, the outer **electrode** is fixed to the outer surface of the glass tube in one united body.

Further, the **fluorescent lamp** according to the present invention comprises a glass tube with a **fluorescent** substance coated on the inner wall surface and a sealing portion formed at each of...

...lead wire penetrating one of the sealing portion of the glass tube airtight, an inner **electrode** connected to the end of the feeding lead wire extended into the glass tube, a...

...tube and the other end is lead out of the glass tube, and an outer **electrode** composing of a conductor of which end is electrically connected to the second feeding lead wire and mechanically fixed thereto.

Further, in the **fluorescent lamp** according to the present invention, the second feeding lead wire one end of which is...

...the glass tube is not exposed to inside of the glass tube.

Further, in the **fluorescent lamp** according to the present invention, the end of the conductor forming the outer **electrode** is **wound** around the second feeding lead wire.

Further, in the **fluorescent lamp** according to present invention, the end of the conductor comprising the outer **electrode** is **wound** around the second feeding lead wire in the same **winding** direction as that of the conductor on the outer surface of the glass tube.

Further, in the **fluorescent lamp** according to the present invention, the outer surface of the glass tube including the outer **electrode** is covered with a translucent resin film layer and thereby, the outer **electrode** is fixed on the outer surface of the glass tube in one united body.

Further, in the **fluorescent lamp** according to the present invention, the second feeding lead wire of which one end buried...

...the other sealing portion has an engaging portion formed at that end.

Further, in the **fluorescent lamp** according to the invention, the discharge medium is composed of xenon gas or a mixture of xenon gas and other rare gas.

Further, a **fluorescent lamp** according to the present invention comprising a glass tube with sealing portions formed at its both ends, a **fluorescent** substance film formed on the inner wall surface of the glass tube, a discharge medium...

...connected airtight by penetrating one of the sealing portions of the glass tube; an inner **electrode** provided at the end of the first feeding lead wire, a second feeding lead wire...

...a locating portion formed on the outer surface of the glass tube, and an outer **electrode** which is a conductor guided by the locating portion and is spirally **wound** around the outer surface of the glass tube the almost overall length of the glass...

...its one end connected and fixed to the second feeding lead wire.

Further, in the **fluorescent lamp** according to the present invention, the outer surface of the glass tube including the outer **electrode** is covered with a translucent resin film layer and thereby, the outer **electrode** is fixed to the outer surface of the glass tube in one united body.

Further, in the **fluorescent lamp** according to the present invention, the discharge medium is composed of xenon gas or a...

...rare gas.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side view of a **fluorescent lamp** showing a first embodiment of this invention;

FIG. 2 is a diagram showing a vertical sectional view of the **fluorescent lamp** shown in FIG. 1 and explaining a structure with a lighting circuit added;

FIG. 3 is a vertical sectional view showing an enlarged one end of the **fluorescent lamp** shown in FIG. 2;

FIG. 4 is a vertical sectional view showing the **fluorescent lamp** in another embodiment of this invention;

FIG. 5 is a vertical sectional view of the **fluorescent lamp** shown in FIG. 4 and for explaining the structure with a lighting circuit added;

FIG. 6 is a vertical sectional view showing an enlarged one end of the **fluorescent lamp** shown in FIG. 5;

FIG. 7 is a schematic diagram for explaining the **winding** process to form an outer **electrode** around the **fluorescent lamp** shown in FIG. 4, in which (a) is a top view and (b) is a sectional view;

FIG. 8 is a diagram showing the driving conditions of the **fluorescent lamp** of the present invention by a lighting power source 18 shown in FIG. 5;

FIG. 9 is also a diagram showing the driving conditions of the **fluorescent lamp** of the present invention by the lighting power source 18 shown in FIG. 5;

FIG...

...is graphs plotted for obtaining pulse frequency areas for stable light output at a given **lamp** tube power with tube powers (watt) and driving pulse frequencies taken at the axis of...

...axis of ordinates, respectively;

FIG. 11 is a graph showing light output intensity of the **fluorescent lamp** at tube power in the above embodiment comparing with conventional mercury-type and xenon-type **fluorescent lamps** ;

FIG. 12 is a graph showing relative total luminous flux (%) against duty ratio of dimming signal when the brightness of the **fluorescent lamp** of the present invention shown in FIG. 4 was controlled using the PWM dimming method...

...view showing the structure of a back-lighting unit for liquid crystal displays with the **fluorescent lamp** of the present invention incorporated;

FIG. 14 is a vertical sectional view showing the **fluorescent lamp** in another embodiment of the present invention;

FIG. 15 is a graph showing luminance distributions of the **fluorescent lamp** of the present invention obtained by measuring the luminance along an axis of the glass when conveying, handling or operating the **fluorescent lamp** in the structure described above and then, required high-frequency voltage is applied;

FIG. 16 is a vertical sectional view showing a structure of an end of the **fluorescent lamp** in another embodiment of the present invention; and

FIG. 17 is a diagram showing modified...

...referring to the drawings.

FIG. 1 is a side view showing the construction of a **fluorescent lamp** according to the present invention, FIG. 2 is a vertical sectional view showing a **fluorescent lamp** including a lighting circuit, and FIG. 3 is a vertical sectional view showing the **fluorescent lamp** shown in FIG. 2 including its enlarged end.

In these diagrams, a **fluorescent lamp** of the invention has a glass tube 11 which functions as a luminous tube and...

...12a, 12b. on the inner wall surface of the glass tube 11, a film of **fluorescent** substance 13 is formed.

Here, the glass tube 11 has an outer diameter of 1...

...provided which is penetrating inside the airtight space and is sealed airtight. A cylindrical inner **electrode** 15 is provided at the end of the lead wire that is extended in the airtight space. The inner **electrode** 15 has a cylindrical body made of, for example, an Ni plate having an inner...

...to provide an electron emission substance on the inner and outer surfaces of the inner **electrode** . The electron emission substance referred to here is an emitter that is used for cold cathode **fluorescent lamps** and made of primarily, for example, alkaline earth metal of barium oxide and borides of rare earth elements such as boric lanthanum. Further, the inner **electrode** 15 may be formed in a column, flat or V shape using Ni or Ni...

...a reduced diameter and opposes to the discharge space . Further, the size of the inner **electrode** is generally 0.6 to 2.0 mm in the outside diameter and 2 to...

...Further, on the outer surface of the glass tube 11, there is provided an outer **electrode** 16 formed by Ni wire conductor of about 0.1mm diameter spirally coiled around the...

...along the overall length in the axial direction (not shown) of the tube. The outer **electrode** 16 can be formed with an Ni or Cu wire of a diameter 0.05 to 0.5 mm. Here, in order to reduce a power loss in the outer **electrode** , a material of the outer **electrode** 16 having specific resistance of 2 x 10-4)(OMEGA)cm or less is desirable...

...as a triangle, a square, a rectangle, a trapezoid or other similar shapes.

The outer **electrode** 16 is **wound** around the glass tube 11 along its axis at a prescribed pitch in order to...

...uniform distribution of luminous intensity along the axis of the tube. That is, although the **winding** pitch of the outer **electrode** varies from 0.1 to 10 mm depending on the outer diameter (or an inner diameter) of a glass tube, the **winding** pitch of the outer **electrode** is varied and adjusted according to the position of the glass tube in order to provide a prescribed distribution of luminous intensity. For instance, if the **winding** pitch is narrowed continuously or gradually as it is separated far from the inner **electrode** , almost uniform luminous intensity characteristic is obtained along the axis of tube.

The continuous change in the **winding** pitch referred to here is to change the **winding** pitch continuously according to a distance along the axis of the tube from the end at which the inner **electrode** 15 is arranged in the glass tube.

Further, the gradual change of the **winding** pitch is attained in the cases shown below. That is, the portion of the outer surface of the glass tube on which a conductor is **wound** is divided into more than 2 sections along the axis of the glass tube , and

(a) the **winding** pitch is uniform in each section but is gradually changed for each section as the section goes away from the internal **electrode** ;

(b) by setting the **winding** pitches at both ends of one of adjacent sections as the upper and lower limits, the **winding** pitch in each section is changed continuously within a range not exceeding these limits and a mean **winding** pitch per unit length of each section is changed optionally according to a distance from the inner **electrode** ;

(c) the **winding** pitch in each section ...changed moderately and is changed rapidly at the boundary of each section; and

(d) the **winding** pitch is so selected as more than two of the above (a), (b) and (c) are combined.

Thus, when the **winding** pitch is narrowed according to the distance from the inner **electrode** 15, an almost uniform or desired luminous intensity distribution characteristic is obtained along the tube axis.

The outer surface of the outer **electrode** 16 thus constructed is covered by a resin film layer 17 like, for instance, a translucent heat shrinking tube and is fixed so that the pitch of the **electrode** does not change in the axial direction. For this resin film layer 17, such tubes ...

...connected to the voltage feed line 18b for increasing weldability.

One end of the outer **electrode** 16 is connected and fixed to the second feeding lead wire 114b at the portion...

...20 to 100 kHz, 1 to 4 kV pulse voltage is applied between the inner **electrode** 15 and the outer **electrode** 16 by a lighting power source 18 including an inverter via the first and second...

...and power feed lines 18a, 18b, respectively. As a result, the discharge starts between the **electrodes** 15 and 16 and ultraviolet rays are radiated in the glass tube 11. The ultraviolet rays thus radiated excite a **fluorescent** film 13 on the inner surface of the glass tube 11, and is converted into...

...the outside of the glass tube 11. Thus the glass tube 11 functions as a **fluorescent lamp** .

The **fluorescent lamp** having the structure according to the invention is able to radiate stabilized **fluorescent** light at a high luminous intensity based on the discharge of xenon gas.

Further, the inner **electrode** 15 in the **fluorescent lamp** of the invention provided at the end of the glass tube 11 is far shorter than the overall length of the glass tube 11. Since the inner **electrode** has an almost same structure as that used in a conventional xenon type **fluorescent lamp** having two inner **electrodes** , the inner **electrode** can be easily manufactured using a conventional manufacturing technology.

Further, the outer surface of the outer **electrode** 16 of the **fluorescent lamp** of the invention is covered and fixed with the heat shrinking resin film layer 17...

...the tube and a high luminous output can be secured. In other words, in the **fluorescent lamp** according to the invention having a structure as described above, the outer **electrode** 16 is **wound** spirally around the outer surface of the glass tube 11 at a prescribed pitch. Since the irregular **winding** pitch affects the luminous distribution in the axial direction of the tube and the light output, the outer surface of the glass tube 11 around which the outer **electrode** 16 **wound** is covered by the translucent resin film layer 17 to insulate and protect the outer **electrode** 16 as well as to closely fix the spirally **wound** wire to the outer surface of the bulb 11.

Further, since the end of this outer **electrode** 16 is connected to the second feeding lead wire 114b by the solder 19 and...

...buried in the other sealed portion 12b of the glass tube 11, variation in the **winding** pitch or disconnection resulting from an external force applied to the outer **electrode** 16 can be prevented. That is, since the outer **electrode** 16 is made of a thin conductor having a diameter below 0.5 mm, its...

...strength is limited. The disconnection is liable to occur when the wire forming the outer **electrode** 16 is **wound** around the outer surface of the glass tube 11, when the wiring to the light power source 18 is made or when incorporating the **fluorescent lamp** in liquid crystal display systems. Suppose a large external force is applied to the outer **electrode** 16, so that the resin film layer 17 was damaged, the outer **electrode** 17 may be dislocated and variation in the **winding** pitch may be caused.

According to the invention, however, since the second feeding lead wire 114b is provided as described above and the leading end of the outer **electrode** 16 is connected and fixed thereto, the above-mentioned problem was solved and a **fluorescent lamp** which always provides a stable high luminous output could be obtained.

FIG. 4 through FIG...

...showing a second embodiment of this invention. FIG. 4 is a side view of a **fluorescent lamp** , FIG. 5 is a vertical sectional view of a **fluorescent lamp** including a lighting circuit, and FIG. 6 is a vertical sectional view of the enlarged end of a **fluorescent lamp** shown in FIG. 5. In these diagrams, the substantially same component elements as those of the **fluorescent lamp** shown in FIG. 1 through FIG. 3 are assigned with the same reference numerals and...

...is used as a discharge medium.

The end of a conductor 16b of the outer **electrode** 16 **wound** spirally around the outer surface of the glass tube 11 is **wound** around the second feeding lead wire 114b and connected by the electric welding or soldering as shown in an enlarged figure of FIG. 6. The end of conductor 16b is **wound** around the second feeding lead wire 114b in the same **winding** direction as that on the outer surface of the glass tube 11.

This structure of the outer **electrode** 16 is effective in the manufacturing process wherein a thin conductor composing the outer **electrode** 16 is **wound** around the outer surface of the glass tube 11 at a prescribed pitch using a **winding** machine. FIG. 7 is a diagram roughly showing such a **winding** process and (a) is a top view and (b) is a sectional view. As shown...

...the axial direction of the tube (an arrow B) at a speed corresponding to the **winding** pitch. Then, a metal wire 72 applied with a definite tension from a metal wire nozzle 71 arranged in the direction perpendicular to the glass tube 11 is supplied. The **winding** of the wire using such a **winding** machine starts at the portion of second feeding lead wire 114b buried in the end of the glass tube 11. At the time when the **winding** starts, the moving speed of the glass tube 11 in the direction of arrow B is lowered and a wire is **wound** closely to the root of the second feeding lead wire 114b at an almost zero **winding** pitch. Then, the moving speed of the glass tube 11 in the direction of arrow B is raised and the wire is **wound** around the outer surface of the glass tube 11 at a prescribed **winding** pitch. In this case, when the moving speed of the glass tube 11 in the direction of arrow B is gradually raised, the **winding** pitch can be made large. Accordingly, the outer **electrode** 16 can be **wound** spirally so that the **winding** pitch is slowly narrowed from the end 12a where the inner **electrode** 15 is arranged in the glass tube 11 toward the opposite end 12b.

Further, the **winding** of the outer **electrode** 16 starts from the second feeding lead wire 14b portion and its end is fixed at this portion as it is thickly **wound** here and therefore, the outer **electrode** can be **wound** at an accurate pitch since there is no loosening or dislocating of the wire during it is **wound** .

Furthermore, since the end of **winding** is fixed at the second feeding

lead wire 14b even after completing the **winding** , the **winding** does not loosened nor dislocated when it is **wound** , incorporated in liquid crystal display systems or conveyed and thereby providing the accurate **winding** pitch.

FIG. 8 and FIG. 9 show the driving conditions of a **fluorescent lamp** of the invention by the lighting power source 18 shown in FIG. 5. In the case of a xenon-type **fluorescent lamp** , a positive column tends to become a thin stripe (a constricted positive column) moving irregularly ...

...its frequency.

FIG. 8 (a) is a graph experimentally showing the relation between such a **lamp** driving pulse waveform and the discharge current of a **fluorescent lamp** . That is, when a driving pulse of peak voltage of 1 kV, pulse power of...

...graph experimentally showing the relation between a pulse waveform and a discharge current of a **fluorescent lamp** at the operating frequency of 20 kHz with the same conditions other than the frequency...a graph plotting a lighting pulse frequency for a stable light output at a given **lamp** power by taking **lamp** power (power supplied to a **lamp** at the time of **lamp** discharge. Unit is watt.) and lighting frequency of driving pulse at the horizontal and vertical axes, respectively. According to the graph, the **lamp** operating state is divided into a stable light output area 101, an unstable light output...

...by increasing gas pressure.

FIG. 11 is a graph showing the luminous intensity of a **fluorescent lamp** according to the above embodiment for the **lamp** power by comparing those of a conventional mercury and xenon **fluorescent lamps** . In the figure,a curve 121 in FIG. 11 shows a relative total luminous flux (%) of the **fluorescent lamp** of the invention. A curve 122 shows that of a conventional mercury-type **fluorescent lamp** provided with two inner **electrodes** . A curve 123 shows that of a conventional xenon-type **fluorescent lamp** provided with two inner **electrodes** and driven by pulse. Finally, a curve 124 shows that of a conventional xenon-type **fluorescent lamp** provided with two inner **electrodes** and driven by sine wave.

As seen from this graph, the total flux of the **fluorescent lamp** of the invention is as much as twice of a conventional xenon-type **fluorescent lamp** and reaches to 50% as much as that of a conventional Hg-type **fluorescent lamp** .

Further, the **fluorescent lamp** of the invention has a stable light output characteristic without flickering even when the brightness...

...showing the structure of a back-lighting unit for a liquid crystal display with the **fluorescent lamp** of the invention incorporated. This back-lighting unit is for a 7 inch size liquid crystal display panel. Two **fluorescent lamps** 142 are arranged at each side of a light guide plate 141. Two **fluorescent lamps** 142 at each side of the light guide plate 141 are accommodated in a reflector...

...The thickness of the thus constructed back-lighting unit is 11 mm. When the total **lamp** power is 11W, the luminance of the back-lighting unit is 6,000 cd/m2...

...unit for a car-navigation display.

FIG. 14 is a vertical sectional view showing a **fluorescent lamp** according to other embodiment of the invention. In FIG. 14, the same component elements as...

...3 are assigned with the same reference numerals and further explanations thereof are omitted.

The **fluorescent lamp** shown in FIG. 14 has one or plural number of locating portions 11a for **winding** consisting of, for instance, a groove or concavo-convex portion formed on the outer surface...

...the glass tube 11. The locating portions 11a are provided at both ends

where the **winding** of a conductor comprising the outer **electrode** 16 starts and ends they also may be provided at the middle part between the ...

...portions 11a are formed in advance continuously or at proper intervals in accordance with the **winding** pitch of the outer **electrode** 16, which varies successively or in step wise along the axis of the glass tube 11 as described above. When a conductor is **wound** using these locating portions 11a as guides, the **winding** at an accurate pitch space as designed is enabled and the **winding** work becomes easy.

Further, the outer surface of the glass tube 11 including the outer **electrode** 16 is covered by the translucent resin film layer 17 such as a heat shrinking resin tube, which fixes the outer **electrode** 16 on the outer surface of the glass tube 11 similarly to the first and second embodiments. Further, the end 16b of the outer **electrode** 16 is connected and fixed by being **wound** around the second feeding lead wire 114b, one end of which is buried in the...

...the glass tube 114b. Accordingly, even when an external force is applied to the outer **electrode** 16, the movement of the conductors in the axial direction of the tube is suppressed...

...shape of glass . They may be concavo and convex shaped portions which fix the outer **electrode** 16 between them. Further, locations and the numbers of the locating portions are selectable depending upon the necessity.

FIG. 15 is a graph showing luminous distributions of a **fluorescent lamp** having a structure described above, which is obtained by measuring the luminance along the axis...external force is applied of the same level normally applied during conveying or operating a **fluorescent lamp** . As shown by a curve A in FIG. 15, it was confirmed that the **fluorescent lamp** of the invention presents almost uniform luminance on the overall length of the glass tube. Further, a curve B in FIG. 15 shows the luminous distribution when the outer **electrode** 16 was directly pulled out without connected to the second feeding lead wire 114b, and an external force similar to that shown above was applied to a **fluorescent lamp** which has no locating portions 11a formed on the outer surface of the glass tube 11 in order for comparing with the **fluorescent lamp** of this invention.

Further, in the graph shown in FIG. 15, the axis of abscissas...

...a distance (cm) from the end 12a of the glass tube 11 where the inner **electrode** 15 is provided and the axis of ordinates shows luminance (cd/m2)), respectively.

FIG. 16 is a vertical sectional view further showing the structure of the end portion of the **fluorescent lamp** according to the further embodiment of the invention. In the diagram, the component elements that are substantially the same as those of the **fluorescent lamp** in the above embodiments are assigned with the same reference numerals and the further explanations...

...while wiring with the lighting power source, conveying or incorporating into the display system the **fluorescent lamp** .

According to the embodiment, therefore, a portion 172 which has a diameter larger than that...

...diameter, length, shape of the glass tube, material, shape and engaging means of the outer **electrode** , material shape and arrangement of the inner **electrode** , material of the translucent resin film layer or kind of gas can be modified by the necessity to cope with the purpose of use and using condition of a **fluorescent lamp** .

...CLAIMS A1

1. A **fluorescent lamp** comprising:

a glass tube both ends of which are sealed airtight and discharge medium filled in the inside;

a **fluorescent** substance layer formed on the inner wall surface of said glass tube;

an inner **electrode** arranged at one end in this glass tube and given

with a potential and
an outer **electrode** comprising a conductor spirally **wound** around said glass tube between its both ends along an axis of said tube and given with the other potential than that is given said inner **electrode** .

2. A **fluorescent lamp** according to claim 1, wherein the discharge medium is Xe gas or a mixture of Xe gas and other rare gas.

3. A **fluorescent lamp** according to claim 2, wherein an outer surface of said outer **electrode** is covered by a translucent resin film layer jointly with said glass tube, thereby said outer **electrode** is fixed to the outer surface of said glass tube in one united body.

4. A **fluorescent lamp** comprising:
a glass tube having a **fluorescent** substance film formed on an inner surface and having sealing portions formed at both ends...

...lead wire penetrating one of said sealing portions of said glass tube airtight,
an inner **electrode** connected to an end of said feeding lead wire extended into said glass tube;
a...

...tube, and the other end is lead out of said glass tube; and
an outer **electrode** composing of a conductor spirally **wound** around an outer surface of said glass tube along an axis of said tube with...

...conductor being electrically connected and mechanically fixed to said second feeding lead wire.

5. A **fluorescent lamp** according to claim 4, wherein said end of the second feeding lead wire buried in...

...of the glass tube is not exposed to inside of said glass tube.

6. A **fluorescent lamp** according to claim 5, wherein said end of the conductor composing the outer **electrode** is **wound** around the second feeding lead wire.

7. A **fluorescent lamp** according to claim 6, wherein said end of the conductor composing the outer **electrode** is **wound** around the second feeding lead wire in the same direction as the **winding** direction of the conductor composing the outer **electrode** on the outer surface of the glass tube.

8. A **fluorescent lamp** according to claim 7, wherein the outer surface of the glass tube including the outer **electrode** is covered with a translucent resin film layer which fixes thereto the outer **electrode** to form an integral body.

9. A **fluorescent lamp** according to claim 8, wherein said end of the second feeding lead wire buried in...

...portion of the glass tube has an engaging part at its end portion.

10. A **fluorescent lamp** according to claim 8, wherein the discharge medium is xenon-gas or a mixture of xenon-gas and at least other rare gas.

11. A **fluorescent lamp** comprising:
a glass tube with a sealing portion formed at both ends; a **fluorescent** substance film formed on an inner surface of said glass tube;
a discharge medium including...

...sealed airtight and penetrating one of said sealing portions of the glass tube;
an inner **electrode** provided at an end of said first feeding lead wire;

a second feeding lead wire...

...a locating portion formed on an outer surface of the glass tube; and
an outer **electrode** that is composed of a conductor and is guided by said locating portion, is spirally **wound** around the outer surface of the glass tube in the almost overall length of an...

...of the conductor is connected and fixed to the second feeding lead wire.

12. A **fluorescent lamp** according to claim 11, wherein the outer surface of the glass tube including said outer **electrode** is covered

by a translucent resin film layer, thereby said outer **electrode** is fixed to the outer surface of the glass tube to form an integral body.

13. A **fluorescent lamp** according to claim 12, wherein the discharge medium is xenon-gas or a mixture of...

?

FLUORESCENT LAMP

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Applicant(s): HARISON TOSHIBA LIGHTNING CORP (JP)
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Abstract

A fluorescent lamp of the present invention has a fluorescent substance film formed on an inner surface and a discharge medium containing xenon-gas filled in the glass tube having sealing portions at both ends. In one end of the glass tube, an inner electrode is arranged. A first feeding lead wire is connected to the inner electrode penetrating one of the sealing portion with airtight. On the outer surface of the glass tube, an outer electrode composed of a conductor spirally wound around it along the axial direction of the tube. At the other end of the glass tube, a second feeding lead wire is buried in the sealing portion at one end and the other end is lead out of the glass tube. An end of the outer electrode is electrically connected and mechanically fixed to the second feeding lead wire. Further, an outer surface of the outer electrode including the glass tube is covered with a translucent resin film layer and thereby, the outer electrode is fixed to the outer surface of the glass tube integrally.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP00/06491

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[7] H01J65/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl[7] H01J65/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1926-1996 Toroku Jitsuyo Shinan Koho 1994-2000
Kokai Jitsuyo Shinan Koho 1971-2000 Jitsuyo Shinan Toroku Koho 1996-2000

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP, 7-272694, A (USHIO INC.), 20 October, 1995 (20.10.95), Full text; all drawings Full text; all drawings (Family: none)	1,2,3 4-13
Y	JP, 8-152406, A (Shimadzu Corporation), 11 June, 1996 (11.06.96), Column 2, line 40 to Column 3, line 12 (Family: none)	1,2,3
Y	JP, 11-073926, A (TOKAI RUBBER INDUSTRIES, LTD.), 16 March, 1999 (16.03.99), Full text; all drawings (Family: none)	3
A	JP, 3-245452, A (TOSHIBA LIGHTING & TECHNOLOGY CORPORATION), 01 November, 1991 (01.11.91), Full text; all drawings (Family: none)	1-13

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
21 December, 2000 (21.12.00)	16 January, 2001 (16.01.01)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

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